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ABSTRACT

For genuine and long-lasting improvement in science education to occur, teachers must be given the necessary and relevant professional development and resources needed. This paper discusses the shortcomings of traditional science inservice programs that do not provide the professional development needed by today's science teachers and argues that radical revisions of long-held views of science inservice training and teacher preparation are needed if schools are to turn the tide of ignorance and illiteracy that all too frequently characterizes U.S. students' performance on national and international standardized achievement tests. Topics discussed include shortcomings of traditional science inservice programs, state initiatives for restructuring the science curriculum, successful science professional development-what it is like and how to go about providing it, and implications to preservice teacher preparation programs. It is concluded that long-term, relevant, sustained, and high-intensity science professional development will have a positive impact on teacher performance and student achievement. Also included is information on Regional Collaboratives for Excellence in Science Teaching. (JRH)

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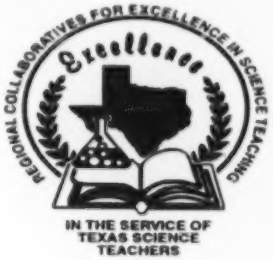
ED 403 134

Building A Successful Collaborative for Professional Development: Lessons Learned and Recommendations"

Texas Regional Collaboratives for Excellence in Science Teaching
Dwight D. Eisenhower Science Professional Development



Presented at

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AETS Annual Meeting
Cincinnati, Ohio
January 9-12, 1997

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Introduction

Changing the face of science education in our nation is everybody's business. At this economic and educational crossroads in our history, the collaboration of all partners is essential for achieving systemic and comprehensive reform in science education. Teachers, educators, scientists, policy makers, business and industry leaders, students, and parents must all be active collaborators for facilitating the urgently needed paradigm shift in science education. Change is an imperative.

In its publication *Introduction to Systemic Education Reform*, the Education Commission of the States summarizes the need for change as follows: "Why Change? (1) Students are more diverse, troubled, and unevenly prepared than in the past. Nearly one in four 6-year-olds lives in poverty; 23% of children live in single-parent families; 20% of all high school seniors have used an illegal drug in the last month; (2) Economic and technological changes require citizens to have much higher level of literacy than in the past; (3) Current teaching practice is inconsistent with research about how people learn; (4) There is persistent evidence that large numbers of students cannot remember, understand, or apply their knowledge; and (5) Current administrative practice in education systems often is out of synch with trends in organizational management toward decentralization of authority, shared decision making, and empowerment of the front-line worker, in this case, the teacher."

Science education has moved from the back burner to the front burner. The commitment and determination of all stakeholders to work together will help turn things around to achieve scientific literacy for **ALL** students. Curriculum, assessment, textbooks, materials, facilities, and technology among many facets of science education must change. However, all of these changes could only be successful if teachers are empowered to feel comfortable at taking risks; at acquiring new knowledge, skills, and competencies; at trying alternative methods of teaching; and at developing and adopting a new paradigm of science education. The message that must be made clear is that **the teacher is the key**, and in order for substantive reform in science education to occur, it is imperative that the two central problems of science curriculum/assessment and teacher qualifications be given equal and significant attention.

It is with empowered teachers that we can begin to end the crisis in science education, that we can again become competitive, and that our students can meet the challenges of a highly scientific and technological twenty first century, and it is the empowered teachers who will help our students become the first in the world in mathematics and science by the year 2000.

For genuine and long-lasting improvement to occur, teachers must be given the necessary and relevant professional development and resources needed. Traditional science inservice programs have many shortcomings and do not provide the professional development needed by today's science teachers. Radical revisions of long-held views of science inservice training and teacher preparation are needed if schools are to turn the tide of ignorance and illiteracy that all too frequently characterizes US students' performance on national and international standardized achievement tests.

Shortcomings of Traditional Science Inservice Programs

Based on numerous participant surveys and evaluations, science teachers identified the following shortcomings of traditional science inservice programs:

- are fragmented, short-term, and lack follow-up activities
- lack message and relevance to what actually happens in the teachers' classrooms
- are of insufficient intensity and duration to make a positive impact on teacher's performance and students' achievement
- lack incentives and do not respond to teachers' needs and concerns
- lack built-in release time for teachers to plan new strategies and to interact with other teachers and professional development experts
- are driven by mandated requirements rather than by student learnings
- are too theoretical and lack practical classroom applications and developmentally appropriate instruction
- are not aligned with recent developments in curriculum, assessment, and methodology nor with technological advances
- lack science content rigor and are not taught by credible professionals in science content and methodology
- do not make effective use of business and industry expertise and resources

- lack cutting-edge instructional and communication technology integration (laser disks, hypercard, media, video, computers, etc.)
- lack the follow-up of supervision and classroom observation and collaboration on actual implementation of desired changes, as well as networking components among teachers and among instructional teams at local, regional, and state levels
- do not provide on-campus support systems of administrative encouragement, ongoing professional development, and instructional materials and consumable supplies
- lack collaboration between colleges of natural science and colleges of education
- are not coordinated with preservice science teacher preparation programs

State Initiatives for Restructuring the Science Curriculum

Characteristics of Elementary Science Curriculum: Using thematic presentation, the elementary science program integrates the life, earth, and physical sciences at each grade level; presents a spiral curriculum with focus on life science at Grades 1 and 4, earth science at Grades 2 and 5, and physical science at Grades 3 and 6; includes all of the processes of science in Grades 1-6; and provides rigorous science content through textbooks and electronic instructional media systems.

Characteristics of Coordinated Thematic Science Curriculum: To help provide continuity throughout the science curriculum and to yield the results needed in science education, the secondary science curriculum in Grades 7 - 10 (Science I, II, III, IV) was restructured. Restructuring the secondary science curriculum provides science instruction that enables ALL students to acquire scientific literacy. In addition, it will provide for advanced preparation for a greater number of students, especially women and minorities, to pursue science-related careers. The Grades 7 - 10 Coordinated Thematic Science Program is designed to provide all students with instruction in biology, chemistry, physics, and earth/space science. At Grades 11 - 12, students will have opportunities to enhance their scientific literacy and acquire advanced preparation in science.

For both elementary and secondary science, thematic presentations provide for the inclusion of relevant scientific facts and information that supports the understanding of the major concepts and principles of science. The curriculum is spaced to facilitate understanding and enhance retention. Only relevant information is taught, and the application of science concepts to everyday life is emphasized. The curriculum begins with the descriptive/experiential, progresses to the semiquantitative/empirical, and culminates with the theoretical and abstract. Discovery learning is emphasized in order to nurture students' curiosity and to develop their higher order thinking skills. Experiential learning provides students with concrete experiences that connect them with the fundamental principles and laws of science. The technological and societal issues of science are among the driving forces of the science curriculum. The curriculum and assessment are planned to nurture students' curiosity and inquiry, develop scientific literacy and address the understanding of science processes, major themes of science, and the applications of science.

Successful Science Professional Development: What Is It Like?

Successful science professional development subscribes to the following underpinnings:

- align professional development activities with new changes in standards, curriculum, assessment, and teaching strategies (i.e., coordinated thematic science, portfolio assessment, and emerging national standards)
- design professional development activities that promote the "All-Students-Can-Learn" philosophy and that respond to teachers' needs and to changes in curriculum and assessment standards, students' expected learnings, and advances in science, technology, and pedagogy
- design highly experiential hands-on activities that have scientific and human significance, providing a combination of basic science content and methodology to integrate the content among the science disciplines.
- provide professional development through collaborative activities among experienced science teachers, science educators, science professors, and instructors, business and industry research scientists, and school administrators, with incentives and hours that accommodate teachers' circumstances and schedules and with instructional teams that include scientists, educators, and practicing master classroom teachers. Instructional teams should model content presentations and instructional strategies that facilitate the integration and thematic instruction of physical, life, and earth sciences.
- provide substantial, yet nonthreatening professional development that is appropriate to the level of the preparation of teachers to meet the teachers where they are, continuously evaluating the program for successes and for improvements needed

- design professional development activities and adapt materials that address the needs of these teachers from underrepresented and underserved populations and teachers who teach students from underrepresented and underserved groups
- offer long-term ongoing support to teachers (i.e., year-long/semester-long/summer-long and follow-up professional development programs to raise the comfort level of teachers and enable them to develop and adopt new paradigms of science teaching and learning)
- provide short-term professional development to improve awareness, teaching, and learning
- engage administrators (principals, assistant principals, counselors, and others) in ongoing awareness and professional development programs that are designed to (1) show the connection between their science teachers' professional development activities and the anticipated positive impact on their student achievement, and (2) to induce campus-level administrative support and encouragement to implement science education reform.
- coordinate preservice teacher preparation programs and the teacher certification process with inservice activities and new curriculum, assessment, and standards, therefore ensuring that newly graduating teachers are part of the change process.

Successful Science Professional Development: How to Go About Providing It.

Texas Regional Collaboratives for Excellence in Science Teaching

Collaboration is the cornerstone of meeting the challenge of developing and implementing successful science professional development. Texas Regional Collaboratives for Excellence in Science Teaching are set out to meet that challenge. The collaboratives provide ongoing support systems of professional development to science teachers to assist them in implementing the state plan of science education reform. With a strong commitment to systemic reform, Regional Collaboratives (Please see attached Map and Chart) are determined to empower science teachers with custom-made relevant professional development programs that are of sufficient intensity and duration to have positive impact on teacher performance and student achievement. Furthermore, the collaboratives will develop the systemic reform leadership capacity at all levels: the classroom, the campus, the administration, the university, the business and industry, and the community.

Professors of science, professors of education, and master classroom teachers form instructional teams to engage inservice teachers with learning experiences that are well-aligned with changes in curriculum, assessment, instructional strategies, and advances in science and technology.

The collaboratives represent a significant multi-regional and multi-institutional commitment to collectively use the available talents and resources to initiate, implement, and accelerate comprehensive changes in inservice professional development that will support inservice science teachers and in the long run impact the development of new science teacher preparation programs in Texas.

The collaboratives are supported through cost-sharing and in-kind contributions by human and financial resources from the state level discretionary Eisenhower science professional development program, Education Service Centers Eisenhower cooperatives, school districts Eisenhower flow-through formula funds, participating colleges and universities in the regions, business and industry, and others. Each of the collaboratives employs faculty, teachers, administrators, and staff of considerable talent and rich resources. However, until now, each of these entities has tackled problems of opportunity in science education separately. The collaboratives are bringing all of the resources to bear on the problem in a coordinated effort and build bridges among those colleges and universities, education service centers, school districts and campuses, and business and industry to share human and financial resources that will maximize the impact of science education reform initiatives.

The Regional Collaboratives science professional development programs provided by are designed to meet teachers' needs as they relate to the Texas Essential Knowledge and Skills, National Science Education Standards and any other changes in curriculum, assessment, expected student outcomes, and advances in technology. The programs are designed to enhance teachers' effectiveness in building scientific literacy for all students and in preparing students who will pursue science-related careers. They provide science teachers with instruction in science content, process skills, laboratory activities, planning effective science lessons, questioning strategies, assessment methods, and instructional strategies that provide for students' needs and make science relevant to their lives and future career aspirations. Instruction emphasizes the coordination of the science disciplines through themes as a driving force for engaging students in developmentally appropriate experiential learning. The interconnections among the science disciplines and the economic, political, and societal aspects of science and technology as they relate to personal and global issues are discussed.

To facilitate interdisciplinary instruction, science teachers who participate in the collaboratives professional development go back to their schools and provide training to other science teachers as well as to teachers of other disciplines using the Planning Groups approach. Planning Groups include science, mathematics, social studies, and English language arts middle school teachers who meet daily to discuss student progress and plan activities for maximizing student learning across all disciplines. RCs should provide an instruction to science teachers that will enable them to lead the other teachers in implementing interdisciplinary teaching using science concepts and themes as the driving forces.

Teachers receiving science professional development programs will benefit from the programs by broadening their science background to include relevant chemistry and physics content and ways to coordinate it with biology and earth/space science. Therefore, they will become more valuable in a marketplace that is increasingly requiring competency in the two highly quantitative sciences of physics and chemistry. They will develop and use well-focused, sound, and meaningful hands-on, minds-on activities that have scientific and human significance, thus freeing themselves and their students from rote memorization of isolated and unrelated facts and information. In addition, teachers will benefit by using science assessment as an instructional tool rather than an end in itself; by learning and utilizing portfolio assessment of student achievement rather than administering traditional paper-and-pencil multiple choice questions type of assessment; by earning college credit; by becoming leaders in their schools; and most importantly, by making science more interesting, meaningful, enjoyable, and relevant to students.

Implications to Preservice Teacher Preparation Programs

For genuine, immediate, and short-term improvement in science education to occur in our nation, teacher empowerment must be the vision of comprehensive, ongoing statewide networks of inservice professional development in each state of the nation. A support system of substantive professional development must provide teachers with the knowledge and skills they need to achieve academic excellence. Furthermore, the system must instill in teachers that expectations of students, by students, parents, and teachers, is key to solving the scientific literacy problem.

For genuine, long lasting, and long-term solutions to the crisis in science education to occur, and to address student needs and learnings required, we must restructure preservice teacher preparation programs in ways that respond to K - 12 curriculum and assessment changes and scientific and technological changes, as well as economic, social, and demographic changes. Because of the collaboration among science and education faculties at colleges and universities and science teachers and educators at school districts and education service centers, it is anticipated that successful models of the Dwight D. Eisenhower inservice professional development programs will find their way to the science teacher preparation programs. Preservice training must be an integral part of the urgently needed change. Preservice training must prepare teachers to utilize different teaching/learning strategies as they engage in facilitating and delivering thematic interdisciplinary instruction that will meet the needs of ALL students.

In Closing

The shortcomings of traditional science inservice teacher preparation programs are sobering and the challenges are daunting. Long-term, relevant, sustained, and high intensity science professional development will have positive impact on teacher performance and student achievement. There are no logical reasons why we cannot transform our educational system in ways that will open scientific literacy for ALL and enable **ALL** students to achieve the high quality scientific and technological literacy required for the twenty first century. It is a matter of commitment, determination, and willingness of all of us to **support the teachers** with successful science professional development. All of us - - teachers, educators, scientists, policy makers, business and industry leaders, students, and parents, - - must work together to place this nation on the cutting edge of reform, excellence, and equity in science education.

Thank you.

Regional Collaboratives for Excellence in Science Teaching

Dwight D. Eisenhower Science Professional Development

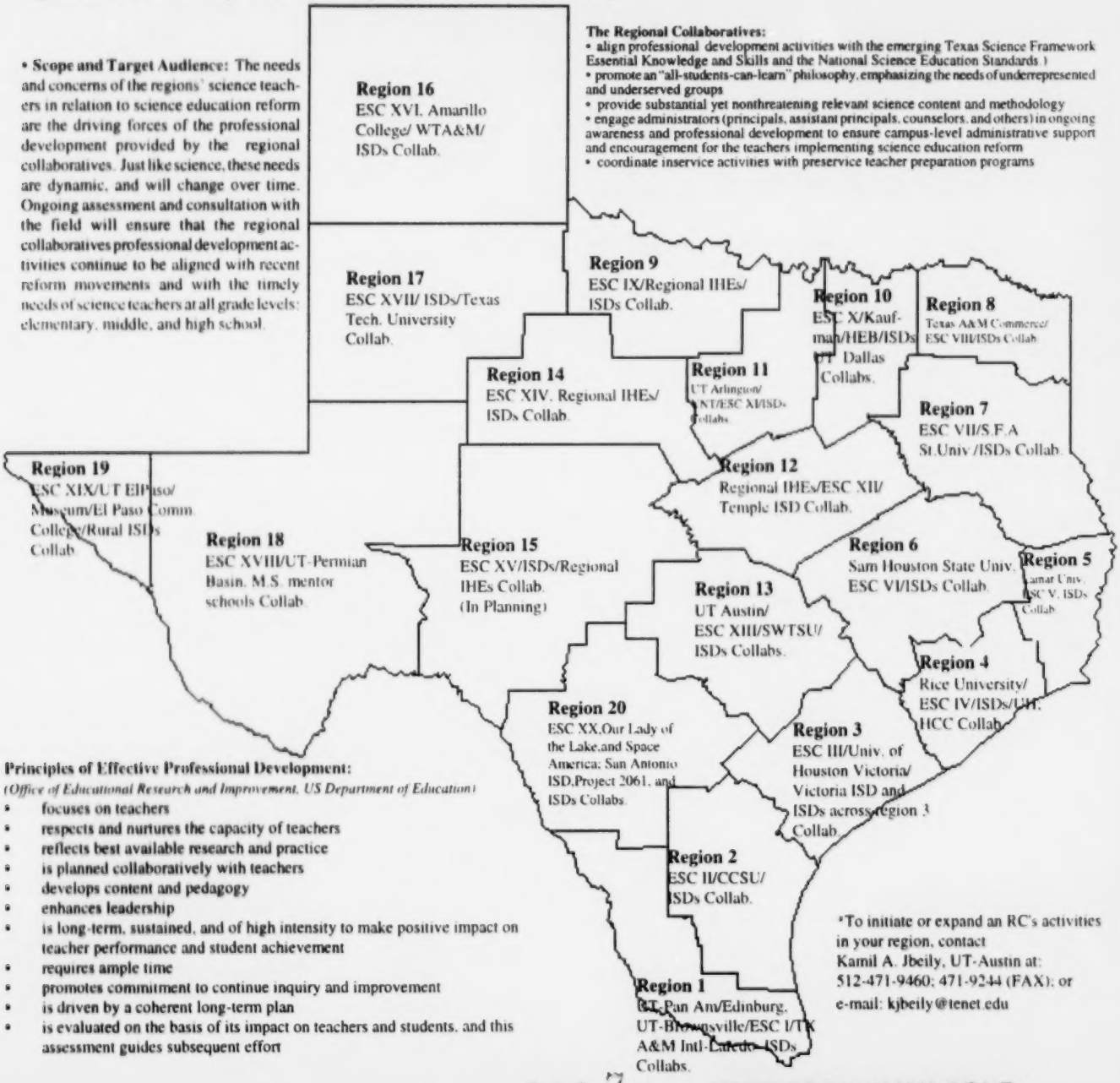
In the Service of Texas Science Teachers

Overview and Background: Regional Collaboratives (RCs)* for Excellence in Science Teaching bring together the UT- Austin's Science Education Center, the Texas Education Agency, colleges and universities, education service centers (ESCs), and school districts in the regions of the state to work collaboratively through cost-sharing and in-kind contribution. The mission of the collaboratives is to provide ongoing state-of-the-art support systems of professional development to science teachers to enable them to implement science education reform. Regional collaboratives design professional development programs that are of sufficient intensity and duration to have positive impact on teacher performance and student achievement. The programs are taught by instructional teams of university science professors, science educators, community college science instructors, science supervisors/ coordinators, and school district master teachers. Typically, programs are offered over a one-year period with contact hours ranging between 105 and 135 with ongoing follow-up activities. The collaboratives promote the commitment, consensus, and support required for strengthening present coalitions, creating new coalitions, developing innovations, and facilitating the implementation of science professional development reform initiatives. The collaboratives will, within the overall goals of Texas Statewide Systemic Initiative, work together with all stakeholders of science education reform in the state to expand and enhance successful professional development programs and to support innovative science education reform initiatives especially in regions where the needs are great and the existing support and resources are lacking.

• **Scope and Target Audience:** The needs and concerns of the regions' science teachers in relation to science education reform are the driving forces of the professional development provided by the regional collaboratives. Just like science, these needs are dynamic, and will change over time. Ongoing assessment and consultation with the field will ensure that the regional collaboratives professional development activities continue to be aligned with recent reform movements and with the timely needs of science teachers at all grade levels: elementary, middle, and high school.

The Regional Collaboratives:

- align professional development activities with the emerging Texas Science Framework Essential Knowledge and Skills and the National Science Education Standards)
- promote an "all-students-can-learn" philosophy, emphasizing the needs of underrepresented and underserved groups
- provide substantial yet nonthreatening relevant science content and methodology
- engage administrators (principals, assistant principals, counselors, and others) in ongoing awareness and professional development to ensure campus-level administrative support and encouragement for the teachers implementing science education reform
- coordinate inservice activities with preservice teacher preparation programs


Region 16
ESC XVI, Amarillo College/ WTA&M/ ISDs Collab.
Region 17
ESC XVII/ ISDs/Texas Tech. University Collab.
Region 9
ESC IX/Regional IHEs/ ISDs Collab.
Region 10
ESC X/Kaufman/HEB/ISDs UT Dallas Collabs.
Region 8
Texas A&M Commerce/ ESC VIII/ISDs Collab.
Region 14
ESC XIV, Regional IHEs/ ISDs Collab.
Region 11
UT Arlington/ UNT/ESC XI/ISDs Collabs.
Region 7
ESC VII/S.F.A St.Univ./ISDs Collab.
Region 19
ESC XIX/UT ElPaso/ Museum/El Paso Comm. College/Rural ISDs Collab.
Region 12
Regional IHEs/ESC XII/ Temple ISD Collab.
Region 18
ESC XVIII/UT-Permian Basin, M.S. mentor schools Collab.
Region 15
ESC XV/ISDs/Regional IHEs Collab. (In Planning)
Region 6
Sam Houston State Univ. ESC VI/ISDs Collab.
Region 5
Lamar Univ. ESC V, ISDs Collab.
Region 13
UT Austin/ ESC XIII/SWTSU/ ISDs Collabs.
Region 4
Rice University/ ESC IV/ISDs/UH, HCC Collab.
Region 20
ESC XX,Our Lady of the Lake,and Space America; San Antonio ISD,Project 2061, and ISDs Collabs.
Region 3
ESC III/Univ. of Houston Victoria/ Victoria ISD and ISDs across region 3 Collab.
Region 2
ESC II/CCSU/ ISDs Collab.
Region 1
ESC Pan Am/Edinburg, UT-Brownsville/ESC I/TX A&M Intl-Laredo- ISDs Collabs.

Principles of Effective Professional Development:

(Office of Educational Research and Improvement, US Department of Education)

- focuses on teachers
- respects and nurtures the capacity of teachers
- reflects best available research and practice
- is planned collaboratively with teachers
- develops content and pedagogy
- enhances leadership
- is long-term, sustained, and of high intensity to make positive impact on teacher performance and student achievement
- requires ample time
- promotes commitment to continue inquiry and improvement
- is driven by a coherent long-term plan
- is evaluated on the basis of its impact on teachers and students, and this assessment guides subsequent effort

*To initiate or expand an RC's activities in your region, contact Kamil A. Jbeily, UT-Austin at: 512-471-9460; 471-9244 (FAX); or e-mail: kjbeily@tenet.edu

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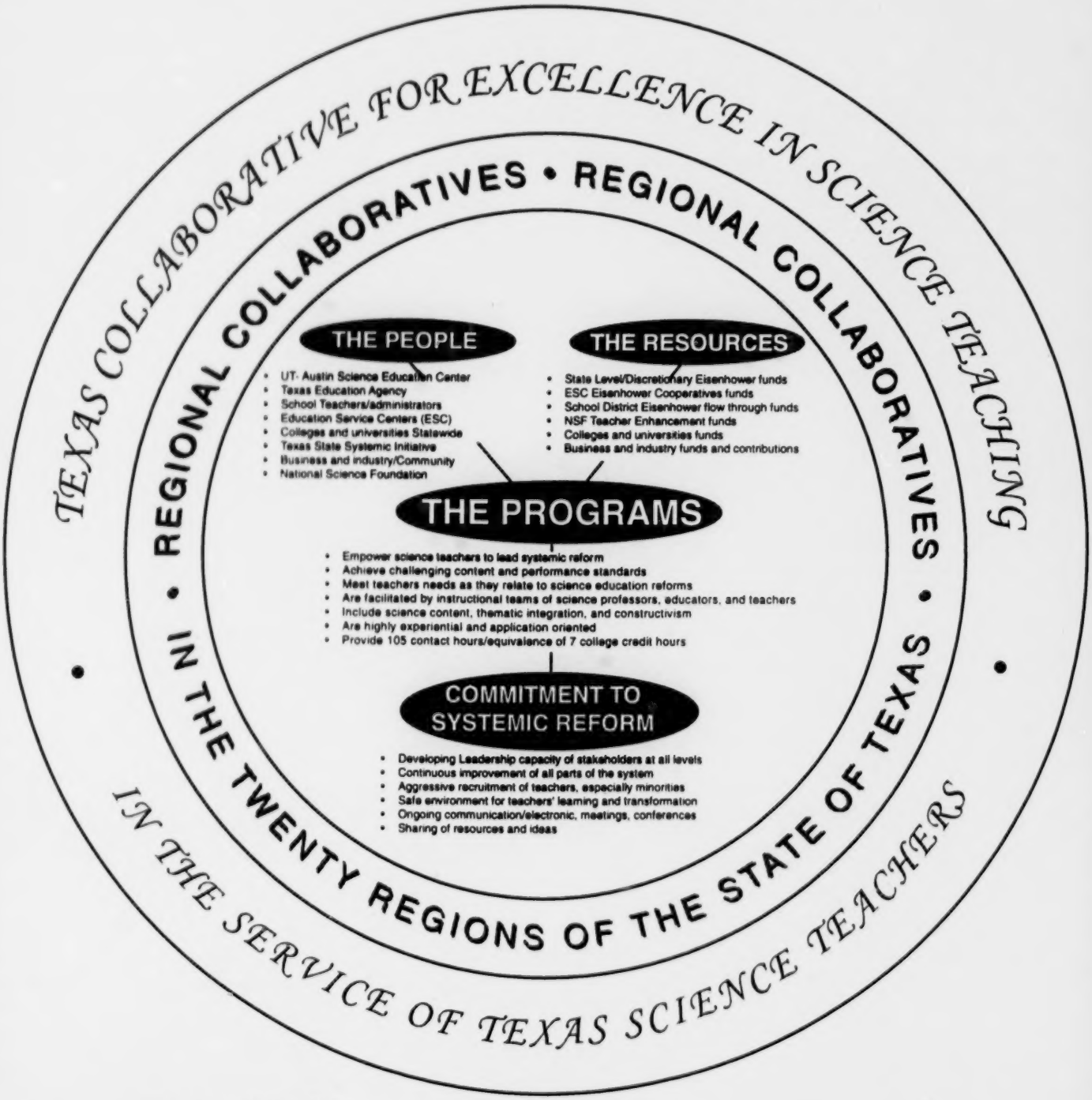
CHART

EMPOWERING SCIENCE TEACHERS TO LEAD SYSTEMIC REFORM

TEXAS REGIONAL COLLABORATIVES FOR EXCELLENCE IN SCIENCE TEACHING

DWIGHT D. EISENHOWER SCIENCE PROFESSIONAL DEVELOPMENT


TEXAS COLLABORATIVE FOR EXCELLENCE IN SCIENCE TEACHING
REGIONAL COLLABORATIVES • REGIONAL COLLABORATIVES
IN THE TWENTY REGIONS OF THE STATE OF TEXAS
IN THE SERVICE OF TEXAS SCIENCE TEACHERS
THE PEOPLE
UT- Austin Science Education Center
Texas Education Agency
School Teachers/administrators
Education Service Centers (ESC)
Colleges and universities Statewide
Texas State Systemic Initiative
Business and industry/Community
National Science Foundation
THE RESOURCES
State Level/Discretionary Eisenhower funds
ESC Eisenhower Cooperatives funds
School District Eisenhower flow through funds
NSF Teacher Enhancement funds
Colleges and universities funds
Business and industry funds and contributions
THE PROGRAMS
Empower science teachers to lead systemic reform
Achieve challenging content and performance standards
Meet teachers needs as they relate to science education reforms
Are facilitated by instructional teams of science professors, educators, and teachers
Include science content, thematic integration, and constructivism
Are highly experiential and application oriented
Provide 105 contact hours/equivalence of 7 college credit hours
COMMITMENT TO SYSTEMIC REFORM
Developing Leadership capacity of stakeholders at all levels
Continuous improvement of all parts of the system
Aggressive recruitment of teachers, especially minorities
Safe environment for teachers' learning and transformation
Ongoing communication/electronic, meetings, conferences
Sharing of resources and ideas

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Regional Collaboratives for Excellence in Science Teaching
Dwight D. Eisenhower Science Professional Development
In the Service of Texas Science Teachers

Long-Range Plan
1996 - 2000
(Excerpt)

MISSION

The Regional Collaboratives for Excellence in Science Teaching are committed to providing Texas science teachers with the highest level of excellence in sustained professional development to develop their leadership capacity and enable them to engage ALL students with interesting, relevant, experiential, and meaningful science learning experiences.

PURPOSE

The purpose of the Long-Range Plan for The Regional Collaboratives for Excellence in Science Teaching is to provide a framework that the stakeholders can use to coordinate and conduct the activities of the collaboratives.

FUNDAMENTAL PRINCIPLES

- All students can learn science.
- All science teachers can develop the knowledge, skill and expertise needed to implement programs that ensure all student can learn science.
- Institutions of higher education must be an integral part of the support systems provided to science teachers to empower them to lead systemic reform in science education.

PREAMBLE

The Regional Collaboratives for Excellence in Science Teaching design and implement professional development programs consistent with the National Science Education Standards, the State Board Of Education long-range plan, and the Texas Essential Knowledge and Skills (TEKS) in Science. Thus, all programs will:

1. Enhance the learning of science content of teacher participants.
2. Enhance the learning of science pedagogy of teacher participants.
3. Enhance the development of lifelong learning of teacher participants.
4. Create teacher development programs that coherently integrate preservice and inservice training of science teachers.

Regional Collaboratives for Excellence in Science Teaching
Dwight D. Eisenhower Science Professional Development
In the Service of Texas Science Teachers

Long-Range Goals
(Summary)

GOAL 1

PROVIDE TEXAS SCIENCE TEACHERS WITH HIGH INTENSITY AND SUSTAINED PROFESSIONAL DEVELOPMENT.

GOAL 2

INFUSE THE CONSTRUCTIVIST LEARNING APPROACH AND EXPERIENTIAL LEARNING WITHIN THE PROFESSIONAL DEVELOPMENT ACTIVITIES.

GOAL 3

IDENTIFY AND DEVELOP VARIOUS TYPES OF VALID AND RELIABLE ASSESSMENTS TO BE USED BY COLLABORATIVES TO MEASURE CHANGES IN TEACHER PERFORMANCE AND STUDENT ACHIEVEMENT.

GOAL 4

ENHANCE LEARNING AND TEACHING USING APPROPRIATE TECHNOLOGY.

GOAL 5

CREATE A STRONG NETWORK OF COMMUNICATION AMONG COLLABORATIVES.

Who We Are and What We Do

Regional Collaboratives for Excellence in Science Teaching
Dwight D. Eisenhower Science Professional Development
In the Service of Texas Science Teachers

The Office of the Eisenhower Regional Collaboratives for Excellence in Science Teaching at The University of Texas at Austin, College of Education, Science Education Center:

* provides statewide leadership in establishing, maintaining, and expanding Regional Collaboratives for Excellence in Science Teaching to design long-term support systems of relevant, sustained, and high intensity science professional development that have positive impact on teacher performance and student achievement.
* delivers presentations throughout the state to foster the achievement of the State's goals of excellence and equity in science education for all students; and coordinates the implementation of state priorities related to science professional development that supports science education reform by building the capacity of leadership at all levels.
* manages and funds over twenty-four regional collaboratives that bring together education service centers, school districts, colleges and universities, and business and industry to pool human, financial, intellectual, and professional resources in support of the science teachers.
* provides regional collaboratives with timely electronic and printed information regarding national science education goals and standards; state science frameworks; successful field-tested strategies and exemplary documents, books, and materials; relevant legislation and funding opportunities; as well as periodic mailouts and news items related to science staff development.
* facilitates and coordinates interregional and statewide collaborations, communications, and meetings to insure sharing of ideas and resources and maximum involvement and participation by the regions.
* serves as the liaison of Eisenhower science professional development with Texas Statewide Systemic Initiative, Southwest Educational Development Laboratory, and other state and national organizations.
* procures other federal, state, and private funds to support the Eisenhower Regional Collaboratives for Excellence in Science Teaching professional development activities.

For Additional Information about The Texas Regional Collaboratives for Excellence in Science Teaching, Please contact:

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Building A Successful Collaborative for Professional Development: Lessons Learned and Recommendations

Based on practical experience of six years of building the network of Texas Regional Collaboratives for Excellence in Science Teaching to provide sustained and high intensity professional development to science teachers, the following is a list of lessons learned and recommendations:

Leadership: At every level: campus, district, region, and state, it is critical to have leaders with strong commitment to the mission of the collaborative. At the state level, the leadership (state director/coordinator) must ensure that the collaboratives are provided with the highest level of financial, political, and professional support; and that the collaboratives are kept on the cutting edge of practice and information. At the regional level, the leadership (project director) must relentlessly pursue regional resources, and hold the collaborative together, removing barriers, and providing incentives to all participants.

Stakeholders: Every partner in the collaborative MUST have a stake in the success of the collaborative. Always, go to people from their point of view and ask the important question: What's in it for them (the teachers, the administrators, the professors of science, the professors of education, the business and industry supporters, and the public at large)? The answer to this question determines whether a collaborative will continue to exist with genuine participation and ownership on the part of all stakeholders.

Time: Sustained professional development requires considerable investment of time to design and implement. Creative and flexible scheduling must be used to meet the needs of teachers. Sustained professional development could take place after school, on saturdays, and in the summer. The minimum frequency should be weekly, biweekly, and/or monthly. The higher the frequency, the more effective.

Resources: Leveraging resources through cost-sharing and in-kind contribution is key to dealig with dwidling resources. Working together, everybody is a winner.

Communication: Communicating information, exchanging ideas, sharing resources, and collectively tackling problems and removing barriers are among the strongest pillars of successful collaboration. This can be accomplished through annual, regional, and local meetings; through electronic networking; through town meetings; through special receptions and teacher and administrators recognition events; etc....

Administrators Support: To successfully implement professional development that will have a positive impact on students achievement, teachers must be supported by their principals. This support should be in the form of encouragement, supplies and materials, as well as recognition.

Reward Systems: The merit and promotion system at colleges and universities should reward science professors, as well as education professors for working with teachers. Teachers must receive incentives including, stipends, tuition fees for courses tied to graduate degree plans, travel expenses, books, supplies, child care, certificates of recognition and achievement, attendance and presentations at professional meeting, connections with university professors and business and industry professionals, internships, and many others. Administrators must see and value the connection between their teachers' professional development and their campus science program and student achievement. Likewise, business and industry must see the value of their support.

Barriers: Barriers and stumbling blocks must be carefully managed with strong determination and commitment to transforming them into stepping stones. Barriers include: discomfort with change, reluctance to collaborate due to the momentum of old paradigm of individualism and competition, teachers' perceptions of traditional inservice programs, recruitment in the absence of incentives, the inexistence of science assessment and accountability.